Electronic Version
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Claims

[c1] I claim an apparatus comprising of an air-to-air heat exchanger 100 connecting the outdoor and indoor air through a plurality of channels, enabling moving indoors air outdoors, and outdoors air indoors and exchange of heat between the indoors air coming out and the incoming outdoors air, means 110 to move the air from indoors to outdoors, while simultaneously moving about the same amount of air in the opposite direction through the said heat exchanger 100, means 120 to physically separate and distance the air inlets and outlets on the outdoor end of heat exchanger to prevent the re-intake of the exhausted air, an air and water contacting chamber for contacting the incoming air from outdoors or recirculating air from indoors with water, comprising a water-impermeable enclosure 200, with baffles or channels 260, made of inorganic catalytic material , with limestone or other mineral filling 280, or other means to increase air-water contact area, which said chamber further comprises of, and further connected with a water circulation loop, comprising of means of dispersing the water in the chamber and mixing it with air, by either creating a mist or water droplet particles within the said

chamber, or other means of increasing air-water contact area, one or more water dispersing devices 270, water filter 350, a water outlet 240, which is connected to a water filter 355, which is connected to a water holding tank 300, which is connected to a pump or pumps 356, to the water heater/cooler 360, which is connected to a pipe 230, which is connected to a water dispersing head 270, thus completing the water circulating loop, means 201 to contain the water droplets or mist within the said chamber, a vent and the valve 210 for the air incoming from the outdoors through the heat exchanger 100, a vent and the valve 220 for the incoming recirculating indoors air, or a three-way vent and a valve to control the amount and the ratio between the outdoors and indoors air entering the said chamber, a vent 250 for the air exiting the chamber towards indoors or towards the air ductwork, means 215 to move the air through the said chamber, one or more UV light sources 600 to irradiate the water in the contacting chamber from inside or outside, and a fully or partially reflective coating on the chamber walls to reflect the light and create multiple passes of light through the chamber, an air ionizer and ozone generator 700 in the chamber air intake path, to create an electric charge potential between the incoming air and the water in the chamber, and create ozone from oxygen in the air, a water tank 300, connected to the

municipal water source 310, with one or more means to monitor and control the water level in the tank 320, which is also vented to the atmosphere through vent 301, and which said tank is also connected to the distillation apparatus 800, and to the water contacting chamber 200 through the inlet 330 and outlet 340, through a pump or pumps 356 to establish a circulation pattern of movement of water in the tank, and circulation between the tank and the water contacting chamber through heater/cooler 360, and the water filters 350 and 355,a heater and cooler means 360 to cool or heat the water flowing from the tank into the contacting chamber 200 using electric, gas, oil, solar energy, heat-pump, or another method, the water filter 350 to filter the water leaving the contacting chamber 200, comprising of one or more filtration means, a back-flushing system activated by a floating lever 281 when the water level above the filter bed in the water contacting chamber rises above the pre-set level, comprising of a water flow reversion switch or a mechanism that closes the valve 289 that goes to the water tank, and opens the valve 288 that is connected to a municipal water source, a vibrator 286 to vibrate or shake the filter bed during back-flushing, a heater 287 to heat the flushing water during back-flushing, a valve 285 to remove the flush water, a water filtration system 355 comprising of a water-permeable

membrane or a fiber bed, and of ion exchanging membrane or fiber bed, with means to regenerate the said ion exchange bed, a water distillation apparatus 800, attached to the water holding tank 300, to further purify the water for drinking, a drinking water dispensing outlet 400, which is drawing water from the circulating system, or from the distillate receiver 900, with means 410 to additionally filter the water during dispensing, such as reverse osmosis unit, and means 420 for heating or cooling the drinking water, A sensor and control system 500 to automatically control the operation of the apparatus to purify the air and provide desired indoor temperature and humidity, based on the indication of the sensors, comprising air quality sensors, such as air and water temperature and humidity sensors, water pH and salinity sensors, carbon dioxide, carbon monoxide, oxygen and air particulate sensors, means to control the temperature of the circulating water, thermostat to control the temperature of the indoor air by controlling the temperature of the circulating water in the chamber, means to control the indoor-outdoor air exchange rate, and the ratio between the incoming air stream from outdoors and the recirculation indoors air that goes through the water contacting chamber, means to control the water circulation rate, means to control the height or the direction of the water dispersing devices 270.

[c2] [Claim Reference]An apparatus as claimed in claim 1, further defined as having an air-to-air heat exchanger of a counter-flow design, with adjustable height water dispersing device of the Ventury type, the baffles 260 made of dolomite, apatite, mica, hydrated alumina, baked clay, hydrotalcite or other minerals comprising of oxides, carbonates or phosphates of calcium, magnesium or aluminum, titania or vanadium-doped titania,

[c3] [Claim Reference]An apparatus as claimed in claim 1, further defined as having the baffles 260 made of titania or vanadium-doped titania

[c4] [Claim Reference]An apparatus as claimed in claim 1, further defined as having a water filter 350 to filter the water leaving the contacting chamber 200, comprising of a single or a multi-layer structure, or mixed bed, with gravel, crushed rocks, coarse sand, limestone, marble, chalk, dolomite, apatite, mica, hydrated alumina, baked clay, hydrotalcite or other minerals comprising of oxides, carbonates or phosphates of calcium, magnesium or aluminum, which minerals can be either untreated, or fully or partially calcined, or otherwise heat treated,

[c5] [Claim Reference]An apparatus as claimed in claim 1, further defined as having a water filtration system 355,

utilizing activated carbon, and ion exchange materials, among them a filtration and ion exchange media made by grafting cationic and anionic species onto films or fibers made at least partially of cellulose, or covalently crosslinked cellulose, crosslinked starch, or other polysaccharides, crosslinked blends of anionically and cationically modified natural and synthetic polymers.

[c6] [Claim Reference]An apparatus as claimed in claim 1, further defined as having the heating and cooling unit 360 located below and near the air-to-air heat exchanger 100.

[c7] [Claim Reference]An apparatus as claimed in claim 1, further defined as having the substantially vertical arrangement of the following units: the filtration system 355 above the water holding tank 300, and the water filter 350 is above the filter 355 and is located at the bottom of the air and water contacting chamber 200,

[c8] [Claim Reference]An apparatus as claimed in claim 1, further defined as having the water holding tank 300, the filtration system 355, the water filter 350 and the air-water contacting chamber 200, all built as one relatively compact unit.

[c9] A distillation apparatus, suitable for water or other liq-

uids, attached to a water holding vessel or tank, which apparatus and the tank are used either as a separate and independent free-standing device, or can be part of another apparatus like the distillation apparatus 800 and the tank 300 in claim 1, comprising of a water holding vessel or tank, which said tank is connected to the municipal water source 310, with one or more means to monitor and control the water level in the tank 320, which tank is also vented with the vent 301 to the atmosphere, a pipe 805, having two ends, one end attached to the water holding tank to receive the water from the tank, and the other end connected to the substantially vertical pipe 810, which said pipe 810 is open at the top and closed at the bottom with a removable plug 811, wherein the tank and the pipes 805 and 810 form two communicating vessels, with equilibrium water level 1000 in the pipe 810 being the same as in the tank 300, which said pipe 810 is either of the same diameter throughout, or is widened 820 at the top, and which said pipe 810 has the outer surface of a simple regular pipe, or is shaped or lined with heat conducting rings 840-1, or spirals 840-2, or has curved, spiked, broken, spiral or other shape or combination of shapes for facilitating the heat transfer between the inside and the outside of the pipe, and which removable plug 811 can have a wire 831 going through to the heating element 830, means 830 to

boil the water at the top part 820 of the pipe 810, with the water vapors escaping over the top of the pipe and down on the outside of the pipe 810, where they are condensed on the way down on the outside surface of the pipe, thus establishing a counter-flow heat exchange between the downwardly moving water vapors and the upwardly moving cold water from the tank, said heating means comprise either infra-red, solar, microwave, or other radiation heat source, or an electric resistance heating element, with wires 831 supplying electrical energy either through the top, or through the bottom, or through the sides of the cover 850, outer cover 850 enclosing the pipe 810, with an air gap between the cover and the top and the walls of the pipe 810, with said cover having an upper end, and a lower end, with the upper end closed to the atmosphere, which can have a sealed hole for the wire that leads to the heating element 830 from above or from the side, and said cover is open to the atmosphere at the lower end, and lets the condensed distilled water fall into the distillate receiver vessel 900, which said cover has a slot at the lower part to accommodate the pipe 805 when the cover is lowered in position, and said cover can also accommodate the electric wire that leads to a heating element 830 from below.

[c10] [Claim Reference]A distillation apparatus as recited in

claim 8, wherein the pipe 810 is made from iron, stainless steel, copper, bronze, or anodized aluminum.

[c11] [Claim Reference]A distillation apparatus as recited in claim 8, wherein the pipe 810 has two parts, a narrower lower part, and a widened top part 820 which maximal diameter is about double to quadruple the diameter of the lower part, and the length is from 5 to 20 percent of the total pipe 810 length, and a plurality of heat conducting channels 840-2 is attached to the lower part of the pipe 810 on the outside in a spiral fashion, with the total width of such channels and the pipe 810 being between 2 and 10 percent wider than the width of the pipe 820, and wherein the outer cover 850 enclosing the pipe 810 is between 1 and 10 percent wider than the total width of the pipe 810 and the channels 840-2, which outer cover 850 is made from a transparent poorly heat conducting or insulating material like a glass.

[c12] [Claim Reference]A distillation apparatus as recited in claim 8, wherein the heating element is of an electric resistance type, which is projected into part 820 from the top of the cover 850, through a sealed hole, or an infrared heat source, which is suspended above the transparent top of the cover 850, and irradiating the inside of the pipe 820, and the heating control means are provided.

[c13] [Claim Reference]A distillation apparatus as recited in claim 8, wherein the gap between the 820 part of the pipe 810 is 3 to 10 percent of the width of the 820 part, and the heat conducting channels 840-2 fit tightly within the cover 850, and the channels and the cover together form a plurality of closed spiral channels through which the vapors travel on the way down.

[c14] [Claim Reference]A distillation apparatus as recited in claim 8, wherein the cover 850 is made from double-walled evacuated insulating glass, or insulating foamed glass, or plastic.

[c15] [Claim Reference]A distillation apparatus as recited in claim 8, wherein the inside of the pipe 810 is packed with the water-conducting porous metal sponge

[c16] A method comprising of (a) exchanging the outdoors and indoors air with the outdoors air moving indoors and indoors air outdoors while efficiently exchanging the heat through the counter-flow heat exchanger, (b) filtering the incoming outdoors air by first creating electrical charge potential between air and water, then passing the air through the water contacting chamber, which traps the particulate pollutants in water droplets, and at the same time purifies the indoors air by (c) recirculating it through the same chamber, (d) disinfecting and oxidiz-

ing the pollutants by irradiating with the UV light the water and air mixture in the contacting chamber and (e) by percolating the air-water mixture through the limestone bed in the chamber, (f) heating or cooling the indoor air through controlling the temperature of the circulating water in the chamber, (g) humidifying or dehumidifying the indoor air through controlling the temperature of the circulating water in the chamber, and through controlling the height of the water-dispersing devices in the chamber, (h) condensing the water from the air by cooling the circulating water below the dew point, and (i) converting it into clean potable water through circulating it through the water filter system along with the rest of the water, between the water holding tank and the water contacting chamber, thus continuously purifying the water, (j) storing the water in the water holding tank, (k) removing ions by filtering through the ion exchange media, and by distilling the water through a distillation apparatus 800, (l) periodically back-flushing the filters and regenerating the ion exchange materials.

[c17] Zwitterionic polymers or blends or crosslinked blends of polymers, having positive and negative charges on the same chain, or on neighboring chains of crosslinked polymers, which are suitable for filtration and ion exchange purposes, and effective in removing partially oxi-

dized pollutants from water, and toxic ions like perchlorate, lead, cadmium and arsenic and other ionic impurities, comprising of ionically and zwitterionically modified synthetic or natural polymers, films and fibers,

[c18] [Claim Reference]Zwitterionic polymers recited in claim 17, or blends or crosslinked blends of polymers, films and fibers derived from polysaccharides such as cellulose, crosslinked starch, chitine or chitosan, wherein such polymers, films and fibers are made by methods comprising of steps of (a) cyanopropylation of films or fibers from cellulose, starch, carboxymethylcellulose, and other natural or modified polysaccharides by addition of aqueous NaOH and acrylonitrile to such polysaccharides, followed by (b) the reduction of the nitrile group to amine, which amine groups are further quaternized by (c) alkylation with alkyl halide, dialkyl sulphate, 2-chloroacetic acid, or other alkylating agents or mixtures of agents, or made by the reaction of films or fibers from cellulose, starch, carboxymethylcellulose, and other natural or modified polysaccharides with (a) toluenesulphonyl chloride, thionyl chloride, or phosphorous oxychloride, followed by (b) the hydrohalogenation to obtain halogen-modified polysaccharides, followed by (c) amination with ammonia or amines, to obtain amino-functional polysaccharides, followed by (d) quaterniza-

tion with methyl iodide, dimethyl sulphate, 2-chloroacetic acid, or other alkylating agents or mixtures of agents, or by reacting polyaziridine or polyvinylpyridine or ethylenediamine with carboxymethyl cellulose, and heating to crosslink, then reacting with the alkylating agent, or by reacting polyaziridine or polyvinylpyridine or ethylenediamine with the alkylating agent, followed by mixing with carboxymethyl cellulose and heating to crosslink, with such obtained fibers or films further optionally oxidized by (e) bromine water, or by hypochlorite in presence of bromide to oxidize the C(6)- carbinol group to carboxyl group, or made by mixing together separately made fibers or films of quaternized amino-functional cellulose or crosslinked starch, and fibers or films of carboxy-functional cellulose or crosslinked starch, which can be further coated onto or mixed with other materials to make a useable film or fibers.

[c19] [Claim Reference]The polymers recited in claim 17 wherein the ion exchanging fibers are made by mixing cationically modified fibers or films and anionically modified cellulose fibers or films, in presence of a non-ionic water-swellable polymer like hydroxyethyl cellulose or starch, and binder and crosslinkers, and react to cure.

[c20] [Claim Reference]The polymers recited in claim 17 wherein the zwitterionically modified fibers or films are made by reacting polyaziridine or polyvinylpyridine or ethylenediamine with carboxymethyl cellulose, then crosslinking, then reacting with the alkylating agent, or by reacting polyaziridine or polyvinylpyridine or ethylenediamine with the alkylating agent, followed by mixing with carboxymethyl cellulose and heating to crosslink.